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NATIONAL MARINE FISHERIES SERVICE
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PROJECT PROPOSAL--BACKGROUND DOCUMENTATION

FISH AGGREGATION STUDY

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The initial phase of the fish aggregation study involving the examination of past studies and records of fish schools associated with drifting objects has resulted in sufficient information for us to press for the implementation of the project. The following highlights form the basis for our recommendation:

1. In recent years the Japanese have expanded their skipjack tuna fishing operations into new grounds, eastward nearly to Midway Island and southward past the equator. The southward expansion has substantially increased their total production of skipjack tuna. In the 1973 fishing season (July 1973-May 1974), for example, the southern water fishery contributed over 100,000 MT (metric tons) of skipjack tuna. All of this increase came through live-bait fishing, while purse seining contributed another 1,100 MT. The Japanese are aware that their southern water fishery has expanded to near its maximum eastward range due to limitations imposed by baitfish supply and survival, and have begun to experiment with purse-seining methods in recent years. Although the results were poor in the first 2 or 3 years, there were some improvements in the last year, 1974.

   American seiners also have attempted to fish in equatorial waters of the central Pacific in the last few years, but have met with mixed results. Good catches were made in a few sets, but fishing in general throughout the several trips were disappointing.

2. Four things were cited for the overall poor showing by both Japanese and American seiners: (a) the generally low school contacts, (b) the wildness of the schools, (c) the deep thermocline, and (d) the clarity of the water. We believe that the use of floating objects, whether natural or artificial, could improve or counteract all four factors listed above.

   a. Low school contacts.

      A weakness about the surface fishery (both pole-and-line and purse seining) is its dependence upon fish schools or bird flock sightings. We know from past studies and observations by this Laboratory that (1) sightings of bird flocks and fish schools diminish with adverse sea and weather conditions, which affect visibility and reduce bird activity; and (2) both the number of birds, and consequently the number of bird flocks, encountered diminish as distance from land increases.

      The consequence of this reliance upon sightings is evident in the configuration of the principal fishing areas for skipjack tuna; the bulk of the catches are made within 500 miles or so from land. Of significance, of course, is the similarity in the maximum distance from land in both the American and Japanese fisheries, including the latter's southern water fishery. It is doubtful that such things as bait holding and survival capabilities and vessel range limitations has too much to do with the similarity in the 500-mile range. The Japanese southern water fishery has demonstrated that bait can be transported over long distances, from home waters to the Marshall Islands, a distance well beyond the 500-mile limit, and the American fleet of purse seiners consist of vessels capable of operating well beyond this limit.

The reduced bird flock sightings in oceanic areas and the range of the present fisheries leads one to conclude that the skipjack tuna is land associated. However, studies showing both adult and larval distribution to be continuous across the Pacific with comparable densities in open ocean as well as near land suggest that this is not completely so. Which leads to the observation that there could be more skipjack tuna in the open ocean than one would suspect, perhaps even as much as that found in the present fishery areas.

One way to improve school contacts in mid-oceanic areas is to set out numerous floating objects. Past studies have shown that skipjack tuna schools are attracted to floating objects and the Japanese have found that skipjack tuna can be caught around drifting logs in the absence of surface signs of schools. Utilizing this knowledge they have tried such objects as two 55-gal oil drums lashed together and a string of 2-m square rafts lashed 100 m apart. From the vicinity of the 55-gal drums they were successful in catching up to 20 MT of skipjack and small yellowfin tunas with the purse seine after about 6 days of drift. Reports by the Japanese pole-and-line vessels fishing around floating objects also indicate respectable catches of skipjack tuna. These varied from an average of 6.4 MT per fishing operation on new objects not long adrift to 9.0 MT on old, long-drifting objects.

Recent information from Japan (Otsu's February 1975 trip) on their purse-seining operations in Papua New Guinea waters in the past year include the following:

(1) Although seining for skipjack tuna in equatorial waters was poor a few years ago, recently, the vessels have been experiencing 80% success (i.e., positive sets) with an average catch approaching 10 tons per day, roughly half the average catch rate of seiners in the eastern Pacific fishery.

(2) Most catches were made around floating logs. Whenever logs were encountered, they were marked by radio buoys and sets were made only in late afternoon or early morning.

Based on the experience of the Japanese, a catch of 20 MT from the vicinity of two 55-gal drums and an average of 10 MT per set, mostly from around floating logs, it does not seem unreasonable to envision a catch rate equal to that made in the eastern Pacific seine fishery. All that would be required to accomplish this is to set out sufficient drift objects to permit two sets in early morning and two sets in late evening, with none of the objects being fished more than once every 5th or 6th day.

b. Wildness of schools.

Wild or fast-moving schools pose a greater hindrance to seining than to pole-and-line fishing. While these schools are on the move they are practically unfishable with the seine. However, those schools that have become attracted to floating objects and have slowed down in their movement may be fishable, as demonstrated by the success of the Japanese seiners. Consequently, fishing could be made possible even in areas containing fast-moving schools by setting adrift a number of floating objects, the number of desired contacts being determined by number of these objects.

c. Deep thermocline.

There is sufficient information in the literature to show that skipjack tuna abound in areas with deep as well as shallow thermocline. Any measure, aside from enlarging the net, that would minimize or counteract the effects of the deep thermocline could increase the chances of success by seining. The Japanese seine catches north of Papua New Guinea, where the thermocline is deep (80-100 m), proves this point. If the drift objects can attract fish schools vertically from subsurface, as inferred in the purse seine success by the Japanese, they would minimize the disadvantage of deep thermoclines.

d. Clarity of the water.

The complaint about clear water is that the fish are able to see the net and thus escape capture. Unlike the deep thermocline situation, where nets can be made to fish deeper, little can be done to change the clarity of the water. Drift objects placed in such waters, however, can benefit by being more easily seen by fish schools from greater distances, both horizontally and vertically. Also once these schools have been attracted, the floating objects could hold the schools long enough for sets to be made on them.

3. The use of floating objects could also be an aid to pole-and-line fishing in mid-oceanic sites. School contact rates by bait boats also could be improved greatly, if instead of encountering drift logs only by chance, a large number of these were to be placed close enough to each other so that several of them could be visited by a single vessel during the course of a day's fishing. Publications by the Japanese on records of fishing around drift logs show that skipjack tuna and small yellowfin tuna could be caught by chumming near the logs even in the absence of surface signs of tuna schools. Other reports (Kimura, Iwashita, and Hattori, 1952) show that skipjack tuna schools picked up on the sonar can be brought to the surface from as deep as 140 m by chumming.

4. We envision a major expansion of skipjack tuna fishing into mid-oceanic areas in the future. In fact this may be the only way to go if the U.S. industry wishes to increase the skipjack tuna landings. Such a move, however, will naturally result in reduced school sightings, as set forth above. The fish aggregation project is aimed at correcting this by increasing school contact rates both for seining and baitfishing, and possibly to make skipjack tuna schools more susceptible to purse seining in waters now considered disadvantageous for this type of fishing.

5. Purely on academic merits the project could give us a better insight on the distribution and abundance of skipjack schools in mid-oceanic areas:

   a. Based on currently available fish observation data, one would conclude that the skipjack tuna are associated with land masses. Yet the nearly continuous distribution of larvae in equatorial waters across the Pacific and a similar distribution of catches of adults by the longline suggest the opposite. How much of this apparent association with land is due directly to the fishery's dependence upon bird flock sightings, which are also land associated, needs to be determined.

   Sufficient coverage of an area with adequate floating objects could give us an idea of the density of schools not now known from observations based only on bird flocks or surface school sightings. Additional data leading to a better estimation of school density in mid-oceanic waters could provide us with better estimates of the resource in the Pacific Ocean.

b. Additionally, more observations of drift objects could lead to a better understanding of the mechanics involved in their attractiveness to schools. At the moment, the only plausible theory advanced by the few who have studied drift objects seems to be that the objects act as schooling companions. This needs to be investigated further.

c. Physiological studies on the skipjack tuna done at the Honolulu Laboratory (mainly by Neill) indicate that those factors which tend to limit the distribution of these fish are (1) the lower lethal temperature (approximately 14° to 18°C), (2) the lower lethal dissolved oxygen concentration (2.8 to 3.5 ml/liter), and (3) an upper temperature bound which varies with size and metabolic rate of the fish, e.g., 30°C for fish weighing 1 kg and 20°C for a 12 kg fish. Because skipjack tuna can exceed their thermal limits for short periods of time, they could forage in water which is too warm, provided that cool oxygenated water is available immediately below it, and vice versa.

   Translating these limits to the ocean, Barkley has come up with a description of the hypothetical skipjack tuna habitat. The normal habitat of all but the smallest skipjack tuna is not the surface layer, but the upper thermocline, for most of the year throughout most of their range. He also hypothesizes that medium and large skipjack tuna should not be found in much of the eastern tropical Pacific, where all the water with sufficient oxygen is warmer than these fish can tolerate.

   The aggregation studies should provide evidence to either confirm or disprove these hypotheses.

d. The above items, particularly 5a-5c, are in line with NOAA's policy governing fisheries programs as set forth in Major Policy and Program Recommendations to the President (Budget request for 1976). That policy is to "provide basic scientific knowledge on abundance, distribution and condition of our fisheries stocks" so that "proper utilization and conservation of our fisheries resources" can be achieved. The aggregation studies are also in line with NOAA's support of programs aimed at "improving the techniques of living marine resource exploitation" to the extent that such programs contribute to better utilization and conservation, and would not be readily undertaken by industry.

6. Finally, from the budgetary standpoint, the cost of the project, exclusive of ship time, would be nominal. The plan calls for testing four types of objects, each designed by incorporating the best features of drift objects from past studies. The most effective

one or two of these will be selected for use in mid-oceanic areas. The cost of the four types of objects to be tested would be in the neighborhood of $900. The nominal cost involved would definitely warrant the initiation of the project.